

E-bike buyers guide

Cycle anywhere with ease on one of the latest crop of e-bikes. We explain the types available and what to look for.

Efficient hot water

Hot water can be one of the biggest home energy users. Read our guide to get you set up for low-carbon showers!

A Sanden Eco Plus hot water heat pump valued at up to \$5000

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ISSUE 151

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Technology for a sustainable future



Scaling up the energy transition

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Technology for a sustainable future

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Robyn Deed

Renew magazine editor

Renewable energy can be beautiful: majestic wind turbines dwarfing the wind technician who scales them for maintenance as on our cover, or solar panels sprouting in the desert among a vibrant red crop of Sturt's desert pea on p. 55. Or it can involve a practical reuse of existing facilities, as with pumped hydro plants converting old mines into water reservoirs.

Beauty and practicality aside, how is the renewable energy transition progressing in Australia? In the last few years, we've seen a satisfying flurry of wind and solar projects. But more recently, some headwinds have hit those projects—output curtailment, planning delays, extra costs—and we haven't yet seen the large-scale energy storage we need being built or incentivised.

In our feature article this issue, Renew's Andrew Reddaway looks at AEMO's recent blueprint for a high-renewable electricity grid—yet another affirmation of the viability of renewables—but then considers the roadblocks holding up such a transition. What's needed to scale up and get pumped hydro and large-scale battery projects happening here?

In our other energy transition feature, Tim Forcey explains why a gas shortfall is predicted and why we need to talk about it—as he says, if we don't, the response will surely be more drilling, as demonstrated in the recent decision to open up onshore exploration in Victoria. Instead, can we make this the impetus to move more homes and industries off gas?

This issue we have not one but two buyers guides. The first is an update to our popular efficient hot water buyers guide. When a hot water system breaks down, it usually happens suddenly and requires urgent replacement, so it's a good idea to do your research now so you're ready. Our second buyers guide is on electric bikes, the wonder machines that have been hitting our streets in ever greater numbers over the last few years. Apart from the guide to types, features and FAQs, we talk to four e-bike riders who are keen proponents—for one it was "love at first sight"; another says, "why would you commute any other way?"

Plus we look at "what is ethical investing?", the benefits of Indigenous-owned renewable energy projects, an experiment measuring smoke infiltration in airtight homes—and much more besides.

As we go to print, our thoughts go out to all those affected by the recent catastrophic bushfires, and now the escalating coronavirus crisis. We hope the acts of kindness that we've seen in response to these disasters are one step along the way to jointly creating a sustainable and more resilient world.



Cover image: GE. This image comes from a GE article about wind technician Kristen Hough and her love of scaling wind turbines, a daily part of maintaining them ([invent.ge/2Qk1N46](https://www.invent.ge/2Qk1N46)). Here she is atop one of the turbines in the Meikle wind farm in British Columbia, Canada, which uses 71 GE wind turbines (180 MW total). Kristen made the transition from operating machinery in coalmines to wind turbine maintenance when the local coalmines were closing. Interesting, then, to link this image to Australia's renewable energy transition. How is our transition scaling up? p. 55.

REGULARS

06 - About us

08 - Up front

12 - Products

88 - Letters

90 - Ask our experts

92 - Pears Report

94 - Classifieds

96 - Member profile

PAGE 85

WIN!

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FEATURES

55

Transition delayed



The transition of most of Australia's electricity supply to renewables is feasible, but has hit some headwinds. What's happening and what can be done about it?

64

Goodbye to Bass Strait gas: what happens next?



As Bass Strait gas supplies dry up, by 2025 the eastern states will have a gas shortfall. Will we end up using dirtier and more expensive gas from fracking, or is this the push we need to get households off gas entirely?

ARTICLES

17

Indigenous power projects

Remote Indigenous communities often rely on expensive and polluting diesel. Some indigenous entrepreneurs are starting to change that.



22

Keeping the smoke out

The recent bushfires led to hazardous air quality over many days in cities and towns around Australia. This experiment measured air quality in leaky vs airtight homes and suggests ways to keep inside air healthy.

27

What is ethical investing?

Ethical investing is booming. But there are questions about this strategy: how do we choose ethical investments, how do they perform and how effective are they in changing the world for good?

33

An off-grid treechange

This home is designed for low energy use and low impact on the local forest and waterways. But how to make an off-grid system work in such a shaded environment?

37

Nurturing your native garden

There's lots of advice around about when and how to prune your roses, but less when it comes to native gardens—what kind of maintenance do they need? We talk to a landscaper about his approach.

42

E-bike buyers guide

BUYERS GUIDE

Are the 2020s going to be the decade of e-bikes? Find out all about the features to look for.



50

Going electric

CASE STUDIES X 4

From relatively new cyclists to committed commuters, four riders tell us about the revelation of e-biking.

68

Efficient hot water guide

BUYERS GUIDE

When a hot water system fails it usually requires an urgent replacement. Use our guide to do your research into the most efficient systems out there, and be prepared when you need it.

78

Testing the waters

CASE STUDIES X 4

We talk to three households and an apartment building manager about their hot water system choices and how they've worked out.

82

EV charging on the road

Melbourne to Sydney is well within reach for the newer range of EVs and chargers. Here's your guide to charging an EV on the road.



86

Driving on sunshine

Topping up their electric vehicle with 'sunshine' is pleasing beyond all reason, say these new EV owners.

01



Easy hemp building

Hemp-based masonry, generally referred to as hempcrete, is relatively new in Australia. Although hempcrete is usually mixed and poured into position on site, that is not the only way to build with hemp masonry.

The IsoHemp block from KOSP Construction Resources in WA is a non-load-bearing hemp masonry product designed for the production of healthy and natural insulating envelopes, partition walls and counter partitions.

IsoHemp blocks come in a range of sizes and shapes, including plain blocks, U-blocks, which can be filled with reinforced concrete to increase building strength or to create lintels, and O-blocks, which have large holes bored through them that are lined up and filled with concrete to create load-bearing pillars inside the wall.

The blocks are laid down with suitable mortar, much like regular bricks, but being made of hemp masonry, they are much larger and lighter, making for easy and fast construction compared to regular brick walls.

Other hemp products from KOSP include a hemp wall panel system, hemp and jute insulation and the RadikHemp structural insulated panel system. Pricing is on application.

Contact:
KOSP Construction Resources
kosp@kosp.com.au
kosp.com.au

02



Expand your battery with lithium

Lithium batteries are still a bit scary for most DIYers, but the BOS 12V extension battery has been designed to take the complexity out of adding lithium storage to existing or new lead-acid battery banks.

The batteries are simply connected in parallel to each 12V lead-acid battery in a bank to increase storage capacity. However, the BOS battery has some other clever tricks as well.

Running a lead-acid battery bank partially discharged for too long can result in permanent capacity loss through sulphation—something that isn't an issue for lithium batteries. So the BOS battery allows the lead-acid battery to be fully charged first before it accepts charge, extending the life of the lead-acid batteries.

Also, by providing a lot of the high current draw for high power loads, the lithium battery reduces general wear and tear on the lead-acid cells.

The LE300 BOS battery has 328Wh of storage and up to 24 LE300 units (7.8kWh lithium capacity) can be connected together, in addition to your lead-acid battery. The design of the BOS batteries means that no additional charge controller or electrical wiring changes are needed. RRP is \$889 per BOS battery unit.

Contact:
Build Solar, ph:(08 8121 4171)
sean@buildsolar.com.au
buildsolar.com.au

03



Smarter water tank monitoring

Water tank gauges range from simple dipstick-type gauges through to multi-tank wireless units. The Kingspan Sensit is one of the latter.

The unit mounts on your rainwater tank and sends data back to a receiver in the house, with a range of up to 200 metres. You monitor data in an app on your smartphone, making monitoring of water levels simple.

Features include empty tank protection and alarms and alerts for low water level or rapid changes in water level, such as from a leak. You can also get email or text alerts when the tank level is high or low, or the tank is filling or draining. You can also monitor your rainwater usage, levels and history, with data and graphs on water consumption and water flows. There's even a predicted 'tank empty' forecast.

The Sensit costs \$180 (Vic, NSW and Qld) and \$185 (WA, Tas and SA) and is suitable for most rainwater tank systems with up to eight tanks.

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bit.ly/2NwAXnJ

Powering Indigenous communities with renewables

Many remote communities rely on polluting and expensive diesel generation. Jodie Lea Martire seeks out the Indigenous entrepreneurs and partnerships driving a more equitable renewable approach.

The United Nations has developed goals for sustainable development, including goal seven: “Ensure access to affordable, reliable, sustainable and modern energy for all.” Australia’s strong renewables growth has meant that by late 2018, 21% of our energy came from renewable sources, with one in five homes powered by rooftop solar. Let’s take a look at whether Indigenous Australians are getting a fair share of this renewable boom, both as consumers and as entrepreneurs.

There is no easy way to quantify Indigenous access to renewable power, partly because it lacks federal oversight. State governments, utilities, developers, infrastructure companies, non-governmental organisations (NGOs) and Aboriginal groups have each connected Indigenous communities to off-grid solutions, but many remote homelands and outstations—communities of fewer than 100 people—rely on diesel generation.

Diesel can cost \$2/litre in the outback, and

the pump price doesn’t include transportation to community, via road or even air in the wet season (imagine your freezer getting disconnected when your road into town gets cut by flooding ... for three months a year). The short-lived First Nations Renewable Energy Alliance, announced in early 2017, reported that some diesel costs reached \$5000 per quarter, while residents of remote NSW communities, at the end of standard ‘poles and wires’ networks, said locals had power bills up to \$3000 per quarter.

Of the 180 Indigenous communities in Western Australia, the regional government-owned utility Horizon Power services 53. Seven large communities currently have solar, and six large Kimberley communities will receive it in the next two years. The remaining 117 outstations are managed by WA’s Department of Communities, which in 2015–16 spent \$16.29 million on diesel for Indigenous communities. Meanwhile a 2016 Centre for Appropriate Technology (CfAT) survey of 401 of the Northern Territory’s 630 homelands and outstations found that 104 (26%) had a hybrid power supply combining solar and generators, 58 (14%) had solar, 92 (23%) had a generator only, 90 (22%) had access to the grid and another 55 (around 14%) had no power at all.

The non-profit subsidiary of NT’s Power and Water Corporation, Indigenous Essential Services, completed the ARENA-funded Solar Energy Transformation Program (SETuP) in late 2019. This sees the integration of 10MW of solar into existing diesel power stations in 25 remote Indigenous communities, saving around 15% on fuel costs and an estimated 94 million litres of diesel over the program’s 25-year life.

The governments of South Australia and



The 209kW Lockhart River Solar Battery Trial on the Cape York Peninsula includes a 60kWh battery backup system and was financed with a renewable energy loan from Indigenous Business Australia.

Image: Australian Sustainable Energy

Keeping the smoke out

How does having a very airtight home impact on smoke infiltration? Cameron Munro and Joel Seagren present results from monitoring Passive House and 'leaky' homes this summer.

The recent tragic summer of bushfires has exposed not only those at the fire front but also millions of Australians living far from the fires to hazardous smoke levels. Smoke is a form of particulate matter (PM). The inhalation of particulate matter is associated with adverse health impacts, particularly respiratory conditions.

The PM levels experienced across much of eastern Australia over summer was far beyond what is typical for our Australian cities and regional areas, and well above recommended levels for healthy air quality; the recommended exposure is a mass concentration of less than 25 micrograms (μg) per m^3 averaged over 24 hours (WHO 2005). Finer particulate matter (PM_{2.5}, or particles of less than 2.5 microns in diameter) can make their way deep into the lungs and can be absorbed into the bloodstream leading both to short- and long-term health consequences, particularly among those with underlying health conditions.

Bushfire smoke particles tend to be very fine, usually under 0.5 microns (Figure 1). These very small particles can travel far from the fire zone and readily penetrate into homes and buildings, even those such as offices or shopping centres with filtered ventilation systems. For example, a coarse G4-grade filter that is commonly employed in residential air conditioning systems will only capture around 10% of smoke particles and a finer F6 filter may capture around half of these particles.

Can airtight buildings help?

One way of reducing exposure to bushfire smoke is to stay indoors and keep windows and doors shut. Homes that are airtight will



This Passive House in Canberra is one of the homes monitored to see how it fared in summer's hazardous smoke.

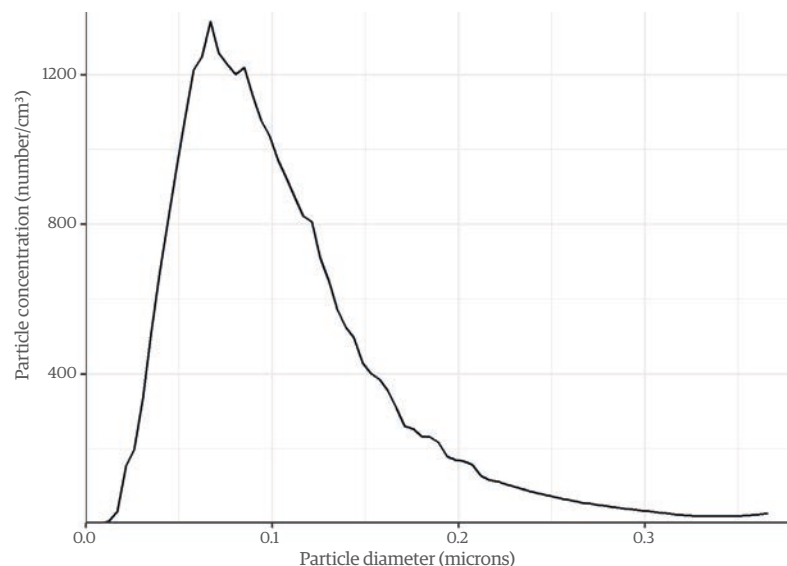


Figure 1: Typical particle composition in bushfire smoke.

Image: Morawska, Moore, and Ristovski 2004 in 'Health Impacts of Ultrafine Particles' at bit.ly/2TdZT5C

What is ethical investing?

Ethical investing is booming. But there are important questions potential investors should ask before jumping aboard, explains Sophie Weiner.

In recent years, more and more of us have become interested in knowing how our invested money is being spent and making sure it's being used for good. As a result, terms like impact investing and ethical investing can now be found in any mainstream financial journal or newspaper. With growing awareness of the dire consequences of unchecked climate change, people are more determined to make their investments spark positive action rather than maintaining the status quo.

But ethical investment is far from simple. For those who have money to invest, there are nearly endless options available. Many 'green' financial products aren't as sustainable as they advertise themselves to be. In other areas, such as superannuation, many

consumers feel they don't have the level of choice or transparency they'd like. Even figuring out what to do with the investments you already have can be a challenge—some advise divestment from anything fossil fuel related, while others say keeping a stake in problematic companies can allow shareholders to encourage them to do better.

Here, we lay out some of the basics of ethical investing and provide a framework to understand both its opportunities and pitfalls.

What is ethical investing?

Environmental concerns are a fairly new component of what's known as ethical investing. Historically, ethical investments or products were those that excluded 'sin' companies, like gambling companies or those

that sell alcohol, cigarettes and firearms. Some came to see these investments as a stain on their portfolios for reasons that ranged from moral to religious. But over the past several decades, sustainable investment has taken centre stage for many ethical investors. These investments are often labelled environmental, social and governance (ESG) investments.

The market for sustainable investments is growing rapidly. In 2017, US \$30.7 trillion was held in investments labeled sustainable or green, an increase of 34% from 2016, according to a report from the Global Sustainable Investment Alliance on five major world regions (bit.ly/39mz7ik). Incredibly, this amounts to nearly a third of all investments managed by financial management firms (except for those that can't be tracked for whatever reason), and in some places closer to half, according to Bloomberg (bloom.bg/2xe81eR).

These green investments run the gamut of financial products, from funds, which use money from many individuals to invest jointly, to bonds, which are a form of debt issued by companies or governments in which both individuals or funds may invest. Mutual funds allow investors exposure to many different types of investment opportunities at once, while bonds usually fund a specific company. Green bonds have been particularly successful in recent years as companies find them an effective tool to raise capital for any project that can be marketed as sustainable.

Even our parent organisation Renew has used funds from impact investing to help install a 36kW solar system on an Indigenous community centre in WA (see image on next page for more information).



Coopers Gap wind farm in Queensland was developed by the Powering Australian Renewables Fund and AGL through green bonds. It will have a capacity of 253MW when it is complete in 2020.

Image: Powering Australia Renewables Fund

Off-grid treechange

Retaining the trees was a key part of this move to the rainforest near Maleny. But how to make an off-grid system work in such a shaded environment? Richard explains their dual-array solution.

Once the rain falling on the metal roof eases and the droplets hitting the large leaves of the bird's nest ferns cease, the chorus of seemingly thousands of frogs intensifies. On many summer evenings, this is how we end the day. We live on a 6000m² block of land, three kilometres from the centre of subtropical Maleny, a small town on top of the Blackall Range north-west of Brisbane.

I've previously written for *Renew* about moving in 2009 from inner Sydney to build a classic 'Queenslander' near the beach on subtropical Bribie Island. With good passive solar design and solar power, we paid no power or water bills and lived in comfort with no heating or cooling systems (other than fans) and lived off our own homegrown vegetables, all of this set in a typical suburban street.

The experience proved to us just how easy it was to move from being a consumer of resources to a net producer.

But our love of the bush led us to another, more recent, challenge. My partner Fiona and I are not too wedded to the surf culture. We don't fish, we don't sail and we have fair skin more suited to the Scottish highlands than the blazing sunlight of Bribie Island.

While living on Bribie Island, we spent a lot of time in the Sunshine Coast hinterland bushwalking, and planting trees and removing weeds with a Landcare group. In fact, we were spending so much of our time in the Maleny region that we decided to move there.

From the coast to the trees

In 2018, we sold up and moved 70 kilometres west and 500 metres higher up, into tree country. The block we've moved to has lots of trees. Some are 50m tall with 1.5m diameter



The challenge with Richard and Fiona's treechange was the trees: they were keen to retain them, but also needed solar access to power their off-grid home. They came up with a solar system design that has both summer and winter optimised arrays. They only had to cut a couple of branches to improve winter sun access.

trunks. Part of the block is rainforest and backs on to a lagoon which feeds into Obi Obi Creek. Platypus have been seen in the lagoon.

Even though we are near the town of Maleny, there is no electricity, mains water or sewerage to our block. While Bribie Island has an average annual rainfall of 1.2 metres, Maleny has almost double that. While Bribie Island has more than 300 days of uninterrupted sun, Maleny has half that.

So our challenge was to build a totally off-grid house in a location surrounded by large trees, where the sun is mostly covered by cloud and where we have to manage all of our water needs and to treat and disperse our waste material.

One other requirement we had was to

be able to cool off every day with a swim. In Maleny this meant that we had to have a pool. But with the lagoon nearby draining into the environmentally sensitive Obi Obi Creek, managing the pool water correctly was critical.

Another consideration was to keep maintenance of the property to a minimum, both to keep those chores manageable (in retirement and when we travel) and to keep the costs down as our income is not what it used to be. I also wanted to prove that living sustainably actually frees up time for more enjoyable pastimes.

Our build commenced in September 2017 and we moved in six months later, in February 2018. During that time we lived in an off-grid cabin, our 'prototype' for the new build.

Nurturing your native garden

Just how much maintenance do you need in a native garden? Robyn Deed gets some tips from landscaper Haydn Barling on how to sustain a beautiful, biodiverse garden in the suburbs.

Native (particularly local indigenous) gardens have a lot to offer for urban gardeners. As global warming effects escalate and critters including beneficial insects and bees are under threat from pesticides, drought and horrific events like Australia's recent bushfires, contributing to biodiversity in our suburbs becomes even more important. Using local plants brings with it food and shelter for native insects and animals, adaptation to the local climate and soils, and often low water requirements. And there are so many beautiful plants to experiment with!

Local indigenous plant nurseries can help with plant selection, but what about when it comes to maintenance? There's a wealth of information around on when and how to prune your roses, fruit trees or hydrangeas, but you have to dig a little deeper

to find information on the maintenance requirements of specific native plants. Do they even need maintenance at all? I sat down for a chat with landscaper Haydn Barling, who specialises in native garden design, to pick his brains about how he approaches maintenance in the gardens he works on.

Get to know your own garden

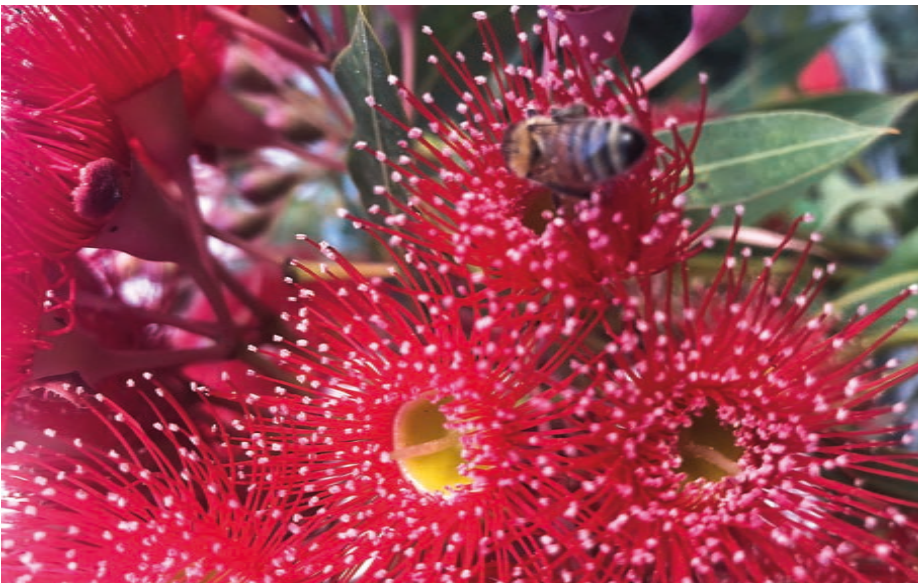
The main point that Haydn stresses several times throughout our chat is that you need to get to know your own garden, and adapt to the seasons—and their changes with global warming as well. He says, "There is an intimacy to be had with your own garden and its microclimate. Plus you've got to watch the seasons as, combined with the vigour in a plant, they're going to dictate when and how much to do."

Haydn notes that there are some general maintenance rules that apply for different types of plants, but that your approach will also depend on what type of garden you'd like. If you want something that looks perfect most of the time, you're going to need to do a lot more work (and perhaps think about getting a professional gardener!). But if you're prepared to have a bit more wildness, say some drier material such as browning kangaroo grass stalks, then the maintenance you'll need to do is much more manageable. Rather than aiming for neatness, this sort of maintenance is about promoting plant longevity and ensuring that your garden looks as good as possible over as much of the year as possible.

Trees will tend to look after themselves, whereas shrubs and groundcovers need a bit more work, he says. But he stresses not to be scared of pruning, as it's a faster cycle with many of these smaller plants. And you can do small parts of the garden at a time: "If your whole garden is looking great and one thing is cut back, it just means your attention is drawn somewhere else."

Haydn says it's good to do maintenance on your shrubs and groundcovers around three times a year to keep them healthy and looking good: a plant-specific prune in early to mid autumn responding to its growth habit and current condition, a big prune in early spring to promote good health and shape, and a tip prune or a 'survival' prune in late spring.

"If you don't do it, what happens is your garden looks great for the first year, then in the second year it's still looking pretty good. By the third year, some of the plants are getting a bit straggly, but still looking pretty full. But come the fourth year, it's getting out of control. People will get us in to prune



Corymbia ficifolia provides beauty and food for bees and birds. But does it need any maintenance?

Pedalling ahead: An e-bike buyers guide

An e-bike is much more than an upgraded bicycle. With extra carrying capacity and riding range, they're a viable alternative to a car for many purposes. But there's a bit more to consider than a conventional bike purchase: Simon Vincett explains the types available and what to look for.



Doing the shopping on a bike becomes increasingly feasible on a cargo e-bike.

Image: Bosch

You simply can't go near a bicycle these days without possibly finding an electric motor lurking.

The bikes of morning commuters, cargo bikes carting young ones to kinder, mountain bikes on the local bush trails and even the sleek steeds of weekend warriors belting past in a lycra flash are frequently electrically assisted. The fact is that e-bikes, as they are known, are now a mainstream alternative to the old unassisted treadly. A few athletes have even been caught with a tiny battery and motor concealed in their bike, to give them an unfair edge in the final sprint.

In the last three years the number of e-bikes imported into Australia has tripled. There are

shops in every capital city devoted to them. For the Australian cycling industry as a whole, e-bikes are the fastest-growing segment.

Peter Bourke, general manager of Bicycle Industries Australia, says projections suggest further growth in the near future. "We won't meet the Netherlands level where 50% of bikes sold are e-bikes, because we don't have the same bike commuting culture. But I can see growth of e-bikes to a quarter of sales in bike shops."

E-bikes are more than an upgraded bicycle. With their extra carrying capacity, speed and ability to extend your riding range, they present an alternative to a private motor vehicle for commuting and local transport.

Riders can take off faster, ride further and use less effort. As we embark on a new decade, challenged as it is with traffic congestion and emissions, it's time to get to the bottom of just what sort of alternative e-bikes offer.

Why get an e-bike?

The fundamental reasons for getting an e-bike are the same pleasures that the bicycle has always offered: freedom and fun. Pedalling your own bicycle means going your own way at your own pace and that's a thrill whether you are nine or 90.

Moreover, with each ride you are honing your health with physical activity. And if your trips by e-bike are replacing car travel, each ride avoids greenhouse gas emissions. Burn fat, not oil!

But why an e-bike rather than a conventional bike?

Well, you have the motor to assist you of course. An e-bike gives you confidence to ride with friends because you know that you'll be able to keep up and that you'll be able to complete the distance. For riding in traffic, the motor gives extra muscle to take off smartly from the traffic lights. For the weary commuter, the battery boosts your depleted reserves and gets you home into a nasty headwind even when you're running on empty. And shower facilities at work are less necessary, as you don't have to work so hard.

You can deal with more weight with a motor to assist you, so you can run errands such as carting home groceries by bike. That's why so many cargo bikes have motors these days. But you can also put panniers on most

Transition delayed

A recent plan by the energy market operator shows that a 90% renewable grid is entirely feasible. But there are roadblocks delaying the transition. Andrew Reddaway analyses the plan and issues.



Image courtesy, Powering Australian Renewables Fund

Broken Hill Solar Plant in NSW. Some solar farms have recently suffered unexpected curtailment of output arising from inadequate transmission.

The electricity sector is the most critical sector in the fight against climate change. It currently accounts for around 34% of Australia's greenhouse gas emissions due to its reliance on fossil coal and gas. Post a major switch to renewables, the electricity grid will allow other sectors (such as transport and heating for buildings) to clean up their energy source via electrification.

In 2018–19, 21% of the electricity flowing into Australia's main electricity grid was generated from renewable energy. This is a good start towards achieving a fully renewable grid, but there's still a long way to go.

In addition to the obvious political obstacles at the federal level, the transition to renewables is being delayed due to an outdated electricity market design that's failing to deliver for Australians.

Enter AEMO's Integrated System Plan

In December 2019 the Australian Energy Market Operator (AEMO) published its 2020 Integrated System Plan (ISP) in draft form. AEMO has always played a role in transmission planning, in addition to operating the short-term wholesale market. The ISP arises from a 2017 recommendation by the Chief Scientist Alan Finkel.

The ISP confirms other researchers' earlier analysis which found that the most economic option to replace our ageing coal-fired power stations is wind and solar, supported by energy storage and new transmission. These assets are relatively capital-intensive, but operating costs are low because their fuel is free. Over a multi-decade lifespan, those future savings become significant.

AEMO can't force generators or retailers

to build or close assets in line with the ISP. However, AEMO may soon gain the power to direct development of new electricity transmission lines which it has found necessary via this planning process. This is an important step to accelerate these new connections.

Step Change—90% renewable by 2040

AEMO modelled five scenarios varying according to many factors including economics and technology uptake. The most interesting is named Step Change and is designed to be compatible with Australian decarbonisation by 2050. In other scenarios such as Central, coal-fired power stations are still replaced with wind and solar, but more slowly since they're retained until end-of-life.

In the Step Change scenario, by 2040–41

Goodbye to Bass Strait gas

After 55 years, Bass Strait gas output is running down. Are you ready, asks Tim Forcey?

Are you thinking of buying a new gas heater? Or, are you future-proofing your home by moving off gas? If it's the latter, that's a good move, because signing up to fossil gas is signing up to an uncertain future.

Here's something you might not have heard. In eastern Australia in 2025—just five years from now—we have no idea where up to half of our wintertime gas will come from. If you haven't heard about this, it's because few people are talking about it.

Is this yet another energy and climate crisis on our near horizon? Is this another case of Australia being unprepared for the inevitable? This somewhat hidden news comes from the Australian Energy Market Operator (AEMO), a regulatory body responsible for planning aspects of our gas and electricity systems. And it's certainly big news! But who's talking about it?

AEMO hasn't had good information

In years past, AEMO has been criticised for failing to collect good information from gas suppliers. The eastern Australia gas industry (or gas 'cartel' as it's often called) treats gas reserve and production information as a tightly held corporate secret. They are allowed to do this, even though minerals beneath the ground are owned by the Crown and should be used for the benefit of the Australian people. Despite AEMO having the legal power to obtain this critical data, they've been reluctant to do so.

Finally in 2019, Exxon Mobil and BHP, the controllers of Bass Strait oil and gas production, had to let the cat out of the bag. Their ability to produce gas at the high volume we've been accustomed to for over 50 years is coming to an end. AEMO broke the news in their 2019 Gas Statement of Opportunities (GSOO) by

publishing two charts: one representing 2018 and the 'good old days' of high rates of gas production and a second showing 2025, the date that a number of formerly prolific Bass Strait gas fields become 'used up'.

2018: the way we were

Figure 1 shows how Australia's network of gas supplies comfortably met demand in the southern states (Victoria, New South Wales, South Australia, Tasmania and the Australian Capital Territory) in 2018.

The top dark jagged line shows the daily ups and downs of eastern Australian domestic gas demand. Throughout the year there is a nearly constant base gas demand for electricity generation, industry and cooking and water heating in homes. On top of that base, gas demand also has a broad peak across the colder months of May through October, as people switch on their gas-fired space heaters.

The dominant red area in Figure 1

represents how gas has traditionally been supplied from the Bass Strait, the Moomba gas field in central Australia and other smaller conventional oil and gas fields. The yellow area shows some Queensland coal seam gas (CSG) being supplied to the southern states via interstate gas pipelines. (You can see this supply network represented in Figure 3.)

The orange area shows some gas that is topping up wintertime supply by being withdrawn from seasonal storage, such as from the underground gas storage facility near Port Campbell, Victoria.

Because Queensland usage is not included in Figure 1, the massive liquefied natural gas (LNG) exports from the port of Gladstone in that state are not shown. (You can see this dramatically illustrated in Figure 4: with those exports starting in 2015, the amount of gas exported is now around three times larger than the amount of gas used domestically in eastern Australia.)



It's time to reduce gas demand. Expanding gas production in Australia mostly now means unconventional gas, from fracking or horizontal drilling. This photo shows coal seam gas wells in Queensland, where producers talk about eventually drilling 40,000 such wells, with detrimental effects on water and emissions.

Image: Lock the Gate Alliance

Warming up: An efficient hot water buyers guide

If you are ready to ditch gas or your current hot water system is reaching the end of its life, it's time to find a more efficient replacement. Lance Turner looks at solar and heat pump hot water options to help you choose the most appropriate system for your needs.

Water heating can be one of the largest energy users in a home. It can account for around 21% of total energy use (on average, according to *Your Home*), adding considerably to energy bills each year. Large energy reductions are possible if you replace a conventional water heater with a heat pump, solar thermal or solar electric system.

What we do and don't cover

From an efficiency and environmental point of view, the future of household energy is electric. Very efficient electric appliances are now available and power from the grid is becoming cleaner. And some households can use the sun—either solar PV panels or a solar thermal hot water system. The CO₂ impact of grid power can be covered by buying carbon offsets or GreenPower, resulting in a 100% renewable energy supply.

Because gas hot water systems burn a fossil fuel with damaging emissions, we don't cover them. One exception is that some solar thermal hot water systems will be connected to a gas heater to boost water temperature in periods of poor weather. Gas used to be seen as the cheaper and cleaner energy choice, at least when compared with burning coal, but that's no longer true. Replacing a hot water system with a modern solar thermal or electric one is often the first step in disconnecting from the gas grid, and the associated costs and greenhouse gas emissions.

In this guide we cover heat pump, solar thermal, electric instantaneous and the newer kids on the block, PV diversion and direct PV water heating systems.



Image: Stiebel Eltron

Heat pumps

A heat pump moves, or 'pumps', heat from one medium into another. Air-source heat pump hot water systems concentrate heat from the air and dump it into the water storage tank. In this way, heat pumps can be considered to use renewable energy—heat from the air—although they do still use some electricity to run.

Other examples of heat pumps are air conditioners and refrigerators, and all have seen great improvements in efficiency over the last few years. Heat pump hot water systems are much more efficient than conventional resistive electric water heaters

which use an element, much like your kettle. Compared to resistive water heaters, they are capable of reducing year-round energy requirements for hot water by at least 50%, and by as much as 80% depending on the climate, brand and model.

Air-source heat pumps are the most common. Ground-source heat pumps (which use buried coils to take heat from the ground) can be even more efficient than air-source heat pumps. However, they are vastly more expensive than air-source heat pumps and are usually not financially advantageous in the milder climates in most parts of Australia. We looked at ground-source heat pumps in *Renew 112*, but there has been little interest in them since then.

Air-source heat pump systems range in price from around \$2500 through to more than \$5000 (before the STC rebate is applied; see box 'Rebates and STCs'). You will occasionally see deals for heat pumps under \$1000, but this includes the STC rebate; watch out for poor quality units—check reviews online.

- To split or not

Heat pump hot water systems are configured as either one-piece (integrated) units or split systems. In an integrated system, the heat pump is mounted on top of or beside the tank. In a split system, the heat pump is in a separate unit like the outdoor unit for an air conditioner, connected to the tank with pipes. Depending on the design, the pipes between the tank and the heat pump unit will carry either refrigerant or water.

An integrated unit has the benefit of simple installation and small size, whereas



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